Status of the European Green Crab, *Carcinus maenas*, in British Columbia - 2006

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by

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ABSTRACT

Gillespie, G.E., Phillips, A.C., Paltzat, D.L., and Therriault, T.W. 2007. Status of the European green crab, *Carcinus maenas*, in British Columbia - 2006. Can. Tech. Rep. Fish. Aquat. Sci. 2700: vii + 39 p.

European green crab, *Carcinus maenas*, is a recently-arrived non-indigenous species on the Pacific Coast of North America. After appearing in San Francisco Bay in the late 1980s, they subsequently spread north, arriving in British Columbia through larval transport in 1998. Fisheries and Oceans Canada noted 24 public reports of European green crab on the west coast of Vancouver Island since 1999.

In 2006, trap surveys were carried out on the west coast of Vancouver Island, Desolation Sound, Discovery Passage and Johnstone Strait. Crabs or moults were also collected from beach surveys during the same period. A total of 375 crabs were trapped from beaches in Barkley, Clayoquot and Nootka Sounds and Esperanza Inlet. Notably high catch rates were reported in Pipestem Inlet (Barkley Sound, 2.28 crabs/trap-day), Pretty Girl Cove (Clayoquot Sound, 1.42 crabs/ trap-day) and Queen Cove (Esperanza Inlet, two beaches, 1.33 and 1.18 crabs/trap-day, respectively). No green crabs were found in Desolation Sound, Discovery Passage or Johnstone Strait.

Sex ratios ranged from 61-80% male with an overall ratio of 66.4% male for the west coast of Vancouver Island collections; one ovigerous female was collected in Barkley Sound in May. Analyses of size frequency and shell condition data indicate that there were at least three year classes present in the population; most crabs were assigned to the 2005 year class. High incidence of damage (injuries or missing limbs) was correlated with high catch rates, suggesting that damage was a result of intra-specific agonistic behaviour rather than unsuccessful predation.

The establishment of green crab populations on the west coast of Vancouver Island increases the potential for further dispersal of the species into northern British Columbia and possibly Alaska.

RÉSUMÉ

Gillespie, G.E., Phillips, A.C., Paltzat, D.L., and Therriault, T.W. 2007. Status of the European green crab, *Carcinus maenas*, in British Columbia - 2006. Can. Tech. Rep. Fish. Aquat. Sci. 2700: vii + 39 p.

Le crabe vert (*Carcinus maenas*) est une nouvelle espèce exotique sur la côte Ouest de l'Amérique du Nord. Après son entrée dans la baie de San Francisco à la fin des années 1980, l'espèce s'est répandue vers le nord par le biais du transport de larves et elle a atteint la Colombie-Britannique en 1998. Le ministère des Pêches et des Océans du Canada a relevé 24 cas où des particuliers ont signalé la présence de crabes verts sur la côte Ouest de l'île de Vancouver depuis 1999.

En 2006, des relevés au casier ont été effectués sur la côte Ouest de l'île de Vancouver, dans le bras Desolation, dans le passage Discovery et dans le détroit de Johnstone. Des crabes ou des exuvies ont également été recueillis dans le cadre de relevés de plage menés durant la même période. Un total de 375 crabes ont été capturés sur des plages du passage Esperanza et des baies Barkley, Clayoquot et Nootka. Des taux de capture particulièrement élevés ont été signalés dans le bras Pipestem (baie Barkley, 2,28 crabes par jour de pêche), dans l'anse Pretty Girl (baie Clayoquot, 1,42 crabe par jour de pêche) et dans l'anse Queen (deux plages du passage Esperanza : 1,33 et 1,18 crabe par jour de pêche, respectivement). Aucun crabe vert n'a été observé dans le bras Desolation, dans le passage Discovery ou dans le détroit de Johnstone.

Le rapport des sexes a varié de 61 à 80 % en faveur des mâles, et le rapport global s'est chiffré à 66,4 % en faveur des mâles pour la côte Ouest de l'île de Vancouver. Une femelle ovifère a été recueillie dans la baie Barkley en mai. Les analyses des données sur les fréquences de taille et l'état des carapaces indiquent que la population comptait au moins trois classes d'âge, et la plupart des crabes ont été classés dans la classe d'âge de 2005. Une corrélation a été établie entre la fréquence élevée de dommages (blessures ou membres manquants) et les taux de capture élevés, ce qui suggère que les dommages sont le résultat d'un comportement agonistique intra-spécifique plutôt que de cas de prédation non fructueux.

L'établissement de populations de crabes verts sur la côte Ouest de l'île de Vancouver augmente le risque de propagation de l'espèce jusque dans le Nord de la Colombie-Britannique et en Alaska.

INTRODUCTION

The European green crab, *Carcinus maenas* (Linnaeus, 1758)(Figure 1), is a well-documented invasive species that has a reputation as both a competitor with native crab species and a major predator on clams, mussels, juvenile fishes and other species in natural settings and in aquaculture (Elner 1981; Ropes 1968; Cohen *et al.* 1995; Grosholz and Ruiz 1995; Jamieson *et al.* 1998; Fairchild and Howell 2000; Grosholz *et al.* 2000; Behrens Yamada 2001; McDonald *et al.* 2001; Jensen *et al.* 2002; Walton *et al.* 2002; Whitlow *et al.* 2003; Behrens Yamada *et al.* 2005; Taylor 2005). Its native range is from Mauritania in northwestern Africa through Atlantic Europe to northern Norway and Iceland. *C. maenas* has become established in South Africa, eastern Australia, Tasmania, the Patagonian coast of South America, the Atlantic coast of North America (from Virginia to Prince Edward Island) and the Pacific coast of North America (LeRoux *et al.* 1990; Grosholz and Ruiz 1995; Behrens Yamada 2001; Jamieson 2002; Jamieson *et al.* 2002; Audet *et al.* 2003; Carlton and Cohen 2003; Ahyong 2005; Behrens Yamada *et* al. 2005; Cameron and Metaxas 2005; Hidalgo *et al.* 2005). A closely related species, *Carcinus aestuarii* (= *C. mediterraneus*) is native to the Mediterranean, Black and Asov Seas, and has become established in Tokyo, Sagami, Osaka and Dokai Bays in Japan (Furota *et al.* 1999; Behrens Yamada and Hauck 2001; Chen *et al.* 2004).

European green crabs were first detected on the Pacific Coast in San Francisco Bay in 1989, and likely had arrived earlier and built up populations before detection (Cohen *et al.* 1995; Grosholz and Ruiz 1995). Likely vectors are thought to be ballast water transport of larvae or discarded packing materials (seaweed) for Atlantic seafood products or bait worms (Behrens Yamada 2001). Bagley and Geller (2000) used molecular genetics to determine that the founding population was the Atlantic coast of North America.

Dispersal from San Francisco Bay was through spread and settlement of pelagic larvae (Grosholz and Ruiz 1995; Behrens Yamada and Hunt 2000; Behrens Yamada *et al.* 2000; Behrens Yamada 2001). Increases in distributional limits were episodic, with green crabs spreading to Estero Americano, CA, in 1989; Bolinas Lagoon, Drakes Estero, Tomales Bay, Bodega Harbour and Humboldt Bay in 1993; six estuaries in Oregon and Washington in 1995 or 1996; and to British Columbia during the 1997/98 El Niño episode (Grosholz and Ruiz 1995; Miller 1996; Behrens Yamada and Hunt 2000; Behrens Yamada 2001). The known range in the Pacific as of 2000 was from Morro Bay, CA, to British Columbia.

Most historic British Columbia reports are from the west coast of Vancouver Island (WCVI), with a single record from Esquimalt Harbour in Juan de Fuca Strait (Table 1, Figure 2). In 1999, five crabs were reported from Useless Inlet, Barkley Sound, and one crab from Esquimalt; two crabs were female and one was unsexed. Between 2000 and 2006, there were 11 reports from seven locations, totaling 29 crabs. Virtually all of these were males; the exceptions were three unsexed crabs reported in 2005 and four females from Kyuquot in 2006.

This report documents results of the first year of a multiple-year program to examine distribution and biological characteristics of European green crab populations in British Columbia. These are the first surveys directed at European green crab in Pacific Canada. The first year explored beaches on WCVI between Barkley Sound and Esperanza Inlet and inside waters north of the Strait of Georgia. Future work will concentrate on northern WCVI, primarily Kyuquot and Quatsino Sounds, and Queen Charlotte Strait on the northeastern coast of Vancouver Island.

METHODS

Trap surveys were conducted on or near selected beaches on WCVI, Johnstone Strait (JS), Desolation Sound (DS) and Discovery Passage (DP)(Gillespie *et al.*, in prep.). Survey locations were determined in advance through examination of charts and consideration of local knowledge.

Initially, the surveys tested two trap configurations (Fukui folding fish traps and Gee minnow traps[1]) and three bait types (frozen herring, prawn bait pellets and canned tuna cat food). Herring and prawn bait were enclosed in standard commercial plastic bait jars drilled with 10 mm holes; the bait jars were suspended inside the upper surface of the traps. Tuna cans were punched with four 5 mm holes and suspended in mesh bags from the upper surface of the traps. After initial tests, gear was standardized to Fukui fish traps with frozen herring.

Generally, six traps were deployed on 60 m groundlines at approximately 10 m spacing, except when fish and minnow traps (six of each) were mixed on a line, then spacing was approximately 5 m. Traps were set overnight, soak time was approximately 18-24 hours. Groundlines were secured by an anchor and marked by a float on the seaward end[2]. Traps were generally set in the intertidal zone, but were occasionally set in the shallow subtidal 1-2 m below Chart Datum.

Crabs were processed individually by trap. For all crabs, we recorded species, sex, carapace width (CW) measured point-to-point (PP) and notch-to-notch (NN)[3], shell condition (categorically determined using shell wear, color and degree of fouling, see Table 2), missing or regenerate limbs, injuries and marks. For *C. maenas*, carapace color on the underside of the thorax was also classified (white, yellow, green, orange-brown or red-brown). Bycatch of fish and other invertebrates was reported as number caught and estimated total weight per string by species. Native species were released after sampling, green crabs were retained and frozen.

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[1] Gee minnow traps were modified by increasing the tunnel opening on each end to 6 cm diameter.

[2] This arrangement facilitated recovery of the traps at any stage of the tide, either by hand at low tide or from a small craft at high tide.

[3] Carapace width measured point-to-point is the longest measurement across the carapace including the 5th anterolateral spines; notch-to-notch measurements are made with vernier caliper tips placed in the notches between the 4th and 5th anterolateral spines.

Age structure was estimated using methods documented by Behrens Yamada (2001) and Behrens Yamada *et al.* (2005), who determined that green crab length frequencies on the Pacific Coast exhibited broad modes that corresponded to age classes. All green crabs <40 mm CW PP were assigned to the 2006 year class regardless of sex or month of capture (Table 3). Male crabs were assigned a 2005 year class if they were between 40-70 mm CW PP and captured in May or June, or between 40-80 mm CW PP if captured in July. Males were assigned to a pooled "older" age class if they were >70 mm CW PP and captured in May or June, or >80 mm CW PP and captured in July. Males between 70-80 mm CW PP captured in July were also assigned an "older" year class if they were coloured orange or red. Females were assigned a 2005 year class if they were between 40-65 mm CW PP. Females between 60-65 mm CW PP were assigned to an "older" year class if they were orange or red, and all females >65 mm CW PP were assigned to the "older" year class.

Trap sampling was conducted in conjunction with beach surveys for non-indigenous species (Gillespie *et al.*, in prep.). Evidence of green crabs (live or dead crabs or moults) was recorded where encountered during beach surveys.

RESULTS

Trap Surveys

A total of 772 traps was set and recovered during 2006 (Table 4 and Table 5). Most of the effort was on the west coast of Vancouver Island; 162 traps at five sites in Barkley Sound, 205 traps at nine sites in Clayoquot Sound and 148 traps at 12 sites in Nootka Sound and Esperanza Inlet[4]. Inside waters north of the Strait of Georgia were also sampled; 101 traps at seven sites in Johnstone Strait, 90 traps at seven sites in Desolation Sound, and 30 traps at two sites in Discovery Passage.

In addition to designed surveys, 12 traps were set at Whiffin Spit, Sooke, in August and 36 at McKenzie Bight, Saanich Inlet, in September. The Sooke traps were set in conjunction with intertidal survey work and the Saanich Inlet traps in response to a public report of green crabs at the site. The Sooke sets did not catch green crabs but because the traps were tampered with before the catch could be measured, data on other species are not available. The Saanich Inlet sets produced red rock, graceful, northern kelp and purple shore crabs but no green crabs (Table 5 and Table 6).

[4] Nootka Sound and Esperanza Inlet are contiguous, thus will be grouped in these analyses.

Beach Surveys

Evidence of green crabs was recorded in several instances from beach survey activities (Table 7, Figure 3). Moults were found at Pipestem Inlet and Hillier Island in Barkley Sound; Cypress Bay, Warn Bay, Whitepine Cove, Whiskey Jenny Beach and Pretty Girl Cove in Clayoquot Sound; and Queen Cove in Esperanza Inlet. Live crabs were captured by hand at Vernon Bay in Barkley Sound, Whitepine Cove and Whiskey Jenny Beach in Clayoquot Sound and observed (but not captured) at Pretty Girl Cove. One dead crab was found at Queen Cove in Esperanza Inlet; it was hidden under an algal mat and had been stepped on the previous day while setting trap lines.

Catch Rates

Green crabs were caught at most sites sampled on the West Coast of Vancouver Island (Table 5, Figure 4). *C. maenas* were captured at three of five sites in Barkley Sound, four of nine sites in Clayoquot Sound and seven of 12 sites in Nootka/Esperanza. Overall catch rates by area ranged from 0.20 crabs/trap-day in Clayoquot Sound to 1.72 crabs/trap-day in Barkley Sound; catch rates were moderate in Nootka/Esperanza (0.38 crabs/trap-day)(Table 8).

Because the surveys were exploratory in nature, we calculated weighted catch rates that included only trap strings from locations where green crabs were found (Table 8). Resulting catch rates were 1.93 crabs/trap-day for Barkley Sound, 0.47 crabs/trap-day for Nootka/Esperanza and 0.37 crabs/trap-day for Clayoquot Sound.

Sites with the highest abundance (estimated by catch rate) were Pipestem Inlet (2.28 crabs/trap-day), Pretty Girl Cove (1.42 crabs/trap-day), Queen Cove Upper (1.29 crabs/trap-day), Queen Cove Entrance (1.18 crabs/trap-day) and Whiskey Jenny Beach (0.92 crabs/trap-day). All other sites had catch rates of 0.33 crabs/trap-day or lower.

No green crabs were caught in traps set in Johnstone Strait, Desolation Sound, Discovery Passage, Sooke or Saanich Inlet.

Sex Ratio

Sex ratios were skewed towards males, with percentage male ranging from 61% in Barkley Sound to 80% in Clayoquot Sound and Nootka/Esperanza (Table 9). One ovigerous female green crab was caught at Pipestem Inlet on May 17.

Size and Age

Canadian and American agencies measure carapace width of crabs differently. The Canadian standard for research is notch-to-notch, while regulations for minimum

legal size use point-to-point measurements.[5] American agencies use point-to-point measurements. We measured most crabs using both standards and plotted the data (Figure 5). A simple linear regression described the relationship between the two measures as:

$$CW_{NN} = 0.9095(CW_{PP}) + 0.4816$$

where CW_{NN} is carapace width measured notch-to-notch and CW_{PP} is carapace width measured point-to-point. The relationship showed very little variation, having an R^2 value of 0.9954.

Size distribution ranged from 32-98 mm CW PP for males and 29-76 mm CW PP for females (Figure 6). The female distribution was broadly unimodal centered around 55 mm CW PP, while the male distribution was bimodal with peaks between 45-70 mm CW PP and 80-90 mm CW PP.

Overall, most green crabs were assigned to the 2005 year class (Table 10, Figure 7). Approximately 90% of male green crabs and 82-88% of female green crabs from Barkley and Nootka/Esperanza were assigned to the 2005 year class. Crabs from Clayoquot Sound were quite different; 40% of males and 44% of females were assigned to the 2005 year class. Forty-five percent of males from Clayoquot were assigned to the "older" year class while 33% of females were assigned to the 2006 year class.

Shell Condition

Most of the crabs examined were either new hard shell crabs (77% of males and 86% of females) or old shell crabs (9% of males and 12% of females)(Table 11). Very few crabs were plastic, soft or springy crabs (3% overall) or very old shell crabs (1% overall) and none were observed in the act of moulting.

Virtually all crabs in the new and new-old shell conditions were either yellow or green in colour (Table 12). Roughly half of the crabs that were old shell or very old shell were orange or red. The few orange-red crabs observed were between 53-85 mm CW PP for males and 47-73 mm CW PP for females (Figure 8).

Injuries

Crabs designated as damaged included those that were missing limbs (legs or claws), regenerating limbs, or had a puncture wound in the carapace (only one crab from

[5] Notch-to-notch measurements are considered more accurate as the crab does not "shrink" as the anterolateral spines wear with increased shell age. This is not as significant an issue for *C. maenas* as the spines are oriented anteriorly, are more robust than in *Cancer* species and the widest possible measurement is not on the spine tips.

Whiskey Jenny Beach)(Table 13). Frequency of incidence of damage varied by location and ranged from 0-36%; the overall frequency of damage was 16%. Four of 13 sites where green crabs were collected had relatively high incidence of damage: Pipestem Inlet, Queen Cove, Pretty Girl Cove and Whiskey Jenny Beach.

Bycatch

An additional 34 species[6] were captured in traps set for green crabs (Table 6). Other species of crab were regularly caught; most common were red rock crab (927 individuals), graceful crab (428 individuals) and hermit crab (358 individuals). Dungeness and northern kelp crabs were fairly common; 85 and 73 individuals, respectively. Helmet and splitnose crabs, yellow and purple shore crabs and coonstripe and bay shrimp were occasionally observed in traps.

Relatively few molluscs or echinoderms entered traps; the only gastropod encountered was dire whelk, which was only captured in Clayoquot Sound and Nootka/Esperanza. The only sea stars were bat and sunflower stars.

Twenty species of fish were identified from trap catches. Most were relatively small, inshore species common in British Columbia (Hart 1973). Large species were rarely caught; the only exception being a 1.5 kg spiny dogfish found in a trap in Chonat Bay. The most commonly encountered species was Pacific staghorn sculpin (760 individuals). The euryhaline prickly sculpin was captured in traps at Pipestem Inlet, Gold River and Queen Cove.

DISCUSSION

Results of these surveys demonstrate that European green crab have established local breeding populations on the west coast of Vancouver Island. Surveys in Johnstone Strait, Desolation Sound and Discovery Passage, as well as limited sampling at Sooke and Saanich Inlet did not find evidence of green crab from inside waters. Combined historic and 2006 survey records show green crab generally distributed in the sounds and inlets south of Brooks Peninsula, with one historic record from Esquimalt, near Victoria (Figure 9).

Carcinus can occupy a wide range of protected habitats including rocky shores, cobble beaches, sandflats and tidal marshes and a wide range of salinities and temperatures (Grosholz and Ruiz 1995). We found catch rates to be generally higher on beaches with low salinity (at the head of inlets and associated with creek and river deltas), in areas near freshwater channels and near cover (*e.g.*, eelgrass beds). Catch rates varied by location with the highest rates, and presumably the highest densities of crabs, in Pipestem Inlet, Pretty Girl Cove and Queen Cove. Beaches at Pipestem Inlet and Pretty

[6] A complete list of common and scientific names of species encountered is included in Appendix Table 1.

Girl Cove were at the head of long inlet systems and had significant freshwater influence. Both beaches at Queen Cove were influenced by the Park River and a creek running across the upper beach and spilling across the cove to the beach at the entrance. Surface salinity, measured by refractometer, was 5-10‰ at the two beaches at Queen Cove, 10‰ at Pretty Girl Cove and 12‰ at Pipestem Inlet. Staghorn sculpins, the fish most commonly caught in traps, are extremely tolerant of low salinity and are known to penetrate the lower reaches of coastal streams (Hart 1973; Mecklenberg *et al.* 2002). The presence of primarily freshwater prickly sculpins in traps at Pipestem and Queen Cove, both of which had high catch rates of green crab, is correlated to relatively low salinity which allows these fish to be found on beaches and may confer advantage to *C. maenas* by deterring competition by larger native crabs (Hunt and Behrens Yamada 2003; deRivera *et al.* 2005).

In general, beaches with high catch rates of green crab did not have high catches of large *Cancer* crabs, and those with high catch rates of *Cancer magister* and *Cancer productus* did not have high catch rates of *C. maenas*. Discrepancies are a result of pooling trap strings by site, *i.e.*, some strings produced *Carcinus* but not *Cancer*, and others produced *Cancer* but not *Carcinus*. We did note mixed catches of *C. maenas* and the smaller *Cancer gracilis* at Pipestem Inlet. In general, Dungeness crabs prefer sandy habitat and red rock crabs prefer rocky habitat (Hart 1982). Graceful crabs prefer muddy habitat and are often found on beaches as they follow the tide to feed.

The preponderance of males in traps may be an artifact of behaviour rather than a true reflection of sex ratio in the population. Traps generally underestimate the female portion of crab populations due to agonistic interactions and reproductive behaviour. Sex ratios biased towards male crabs was also noted by Behrens Yamada *et al.* (2005) from samples trapped in Oregon and Washington.

European green crabs grow faster and achieve larger maximum size on the Pacific coast of North America than they do on the Atlantic coast of North America and in their native range (Berrill 1982; Jamieson *et al.* 1998; Baeta *et al.* 2005; Behrens Yamada *et al.* 2005). Torchin *et al.* (2001) postulated that increased performance of green crab might be due to a combination of factors including reduced competition, better environmental quality (*e.g.*, increased food resources) and/or absence of natural enemies such as predators or parasites. They concluded that decreased prevalence of parasites was a significant factor in increased performance of introduced populations.

Ventral shell coloration varies from yellow to green to orange to dark red and this shift is related to shell age; *i.e.*, new shells are yellow then turn green, orange and eventually red (McGaw and Naylor 1992; McGaw *et al.* 1992; Reid *et al.* 1997; Wolf 1998; McKnight *et al.* 2000; Rewitz *et al.* 2004; Styrishave *et al.* 2004; Lee *et al.* 2005; Brian *et al.* 2006; Todd *et al.* 2006). The color phases have also been linked to differences in physiological ecology; yellow or green crabs have broader physiological tolerance than orange or red crabs, have greater osmoregulatory capability, can withstand hypoxia better and may even be more tolerant of pollution (Reid and Aldrich 1989; Reid *et al.* 1997; Styrishave *et al.* 2000, 2004; Lee *et al.* 2003, 2005). Large red male crabs are

stronger than green males and out-compete them for habitat, mates and prey (Kaiser *et al.* 1990; Reid *et al.* 1997). Styrishave *et al.* (2004) postulated that green males are utilizing a "growth" life history strategy while red males are in a "reproductive" life history strategy. Differences in tolerances and competitive advantages are expressed in the crab's distribution with red males more common in subtidal habitats and green males more common in stressful, marginal estuarine and rocky intertidal habitats (Kaiser *et al.* 1990; McGaw *et al.* 1992; McKnight *et al.* 2000; Lee *et al.* 2005).

Length frequency distribution, shell condition and colour data suggest that several year classes are present on WCVI. Using length-frequency and shell condition, we estimated that crabs caught in 2006 in British Columbia were primarily made up of one-year-olds, representing the 2005 year class. Because recruitment of European green crab was poor on the Pacific Coast in 2002 and 2004 (Behrens Yamada and Randall 2006), large crabs likely represent the 2003 year class.

Differences in year-class structure between areas may be an artifact of sample size. The Clayoquot Sound samples are the smallest of the three areas (Table 10), although the Nootka/Esperanza samples are not much larger and have similar sex ratios (Table 10). Barkley Sound samples are of adequate size, at least 100 of each sex.

The four beaches that yielded damaged green crabs were also the four beaches with the highest catch rates. If catch rate is correlated with density, then high incidence of damage is correlated with high density of green crabs in a location. This leads us to believe that non-fatal damage is a result of intra-specific agonistic interactions, rather than inter-specific interactions, which are likely fatal (Hunt and Behrens Yamada 2003).

CONCLUSIONS

C. maenas has established local breeding populations in several sounds and inlets on the west coast of Vancouver Island. To date, there is no evidence of populations from inside waters of the Strait of Georgia through Johnstone Strait. Green crabs can live at least six years on the Pacific Coast, therefore a strong recruitment event is required at least every five years to maintain populations in the Pacific Northwest and British Columbia (Behrens Yamada and Randall 2006). The detection of a strong 2005 cohort in these surveys ensures that a breeding population is available to produce potential recruits through at least 2011.

Green crabs in British Columbia arrived as larvae from southern populations in 1998, a year of strong northern transport (Behrens Yamada *et al.* 2005). The range of European green crab on the Atlantic coast of North America expands northward in warm years and contracts in colder periods (Welch 1968; Berrill 1982). Thomson *et al.* (1989) documented the seasonally persistent, poleward flowing Vancouver Island Coastal Current, which could serve as an alongshore conduit to transport green crab larvae from Barkley Sound to Brooks Peninsula and beyond. In addition to this means of northward dispersal, the occurrence of abnormally warm temperatures and strong northward coastal

transport in the next few years might allow populations on WCVI to serve as larval sources to seed new populations in northern BC or possibly Alaska (Cohen *et al.* 1995; Jamieson *et al.* 1998; Hines *et al.* 2004; Behrens Yamada and Randall 2006).

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Table 1. Location and collection information for public reports of European green crab, *Carcinus maenas*, in British Columbia, 1999-2006.

Year	Month(s)	Location	Latitude	Longitude	Comments
1999	6/7	Useless Inlet	48°59'N	125°03'W	2 male, 2 female, 1 unsexed (1 male 75 mm CW, 1 female 58 mm CW)
1999	8	Esquimalt Harbour	48°26'N	123°26'W	1 male (65 mm CW)
2000	5	Lemmens Inlet	49°12'N	125°52'W	2 males (55, 68 mm CW)
2000	8	Bligh Island	49°39'N	126°31'W	1 male (61 mm CW)
2001	8	Little Espinosa Inlet	49°58'N	126°54'W	3 males (73, 79, 81 mm CW)
2002	6	Port Eliza	49°56'N	127°03'W	1 male (67 mm CW)
2003	7	Little Espinosa Inlet	49°56'N	127°03'W	1 male (64 mm CW)
2005	5/6/8	Little Espinosa Inlet	49°56'N	127°03'W	5 males (57, 68, 81, 83, 85 mm CW); 3 unsexed (all ~60 mm CW)
2005	5	Kyuquot	50°02'N	127°22'W	1 male (57 mm CW)
2005	6	Pipestem Inlet	49°02'N	125°12'W	1 male moult (60 mm CW)
2006	6/7	Kyuquot	50°02'N	127°22'W	5 males (52, 44, 70, 68, 83 mm CW); 4 females (55, 64, 51, 61 mm CW)
2006	7	Mayne Bay	48°59'N	125°19'W	1 female 69 mm CW
2006	8	Pacific Rim National Park	48°55'N	125°19'W	1 male ~65 mm CW

N.B. - All carapace width measurements (CW) are point-to-point.

Table 2. Shell condition codes and descriptions for European green crab, *Carcinus maenas*, from British Columbia surveys in 2006.

Adapted from DFO standard shell age assessments for Dungeness crabs.

Shell Condition	Code	Description
Plastic	4	A newly moulted crab likely 1 - 2 days old. Underside of thorax will be primarily white rather than yellow, dark green or brown and every part of the shell can be easily deformed with light pressure. A short-duration stage immediately following a moult.
New Soft	3	A recently moulted crab. Underside of thorax will be white or yellow and some springiness in the shell can be detected. Also a very short stage probably lasting less than a week.
New Springy	2	Carapace will be hard but legs may remain slightly springy. Underside of thorax will be lemon yellow or greenish-yellow. There will be no fouling, barnacle growth or abrasion of carapace spines, claws or tips of dactyls.
New Hard	1	Underside of thorax will be green or brown. Few if any signs of wear or abrasion on carapace. May have barnacles but these will be small. Very little claw wear and cusps of claws are not rounded and worn. As these crabs age it will be increasingly difficult to determine if the shell is new or old.
New-Old	8	Shell has a mixture of characteristics of new hard and old shell conditions. May exhibit some fouling and barnacle growth. Shell shows signs of wear, especially on cusps and tips of claws, but the crab is still relatively clean and vigorous.
Old	6	A crab showing claw wear and possibly barnacle encrustation or other fouling growth but otherwise a healthy, viable crab. Shell may appear very clean and bright but claws will show unmistakable signs of wear (*i.e.*, worn cusps, faded colour near cusps and tips, broken claw tips). Carapace spines and tips of dactyls will also be blunted. Often have scars and abrasions and areas of blackening around injuries.
Very Old	7	Extreme shell and claw wear, may have shell disease; tips of walking legs may be black or rotting off. These crabs always appear lethargic and moribund. The crab probably has not moulted for 2 or more years. The crab is probably in terminal moult. Barnacles often present, usually large or two size classes.
Moulting	5	Old shell which is splitting at the suture line (seam between upper and lower halves of the shell) and is in process of moult. Suture *must be opening at time of observation*. This stage is of very short duration, several hours at most.
Moult	9	Discarded carapace, usually found on a beach, which may or may not be attached to rest of body

Table 3. Age structure criteria based on month of capture, size and shell condition of European green crab, *Carcinus maenas*, from British Columbia surveys in 2006 (*fide* Behrens Yamada 2001, Behrens Yamada *et al.* 2005).

Year Class (Age)	Sex	Month Captured	Size (mm CW PP)	Shell Condition/Colour
2006 (0+)	Male/Female	May-July	<40	All
2005 (1+)	Male	May-June	40-70	All
		July	40-80	All
		July	70-80	Yellow-Green
	Female	May-July	40-60	All
		May-July	60-65	Yellow-Green
Older (2+ and greater)	Male	May-June	>70	All
		July	>80	All
		July	70-80	Orange-Red
	Female	May-July	>65	All
		May-July	60-65	Orange-Red

Table 4. Date and location of British Columbia green crab trap surveys, May-September 2006.

Set	Location	Date	Latitude	Longitude	PFMA
1	Useless Inlet	May 15, 2006	48°59.5'N	125°01.8'W	23-6
2	Useless Inlet	May 15, 2006	48°59.6'N	125°01.7'W	23-6
3	Vernon Bay	May 15, 2006	49°00.5'N	125°08.6'W	23-6
4	Robber's Pass	May 15, 2006	48°54.0'N	125°07'W	23-5
5	Pipestem Inlet	May 16, 2006	49°02.3'N	125°12.2'W	23-10
6	Pipestem Inlet	May 16, 2006	49°02.3'N	125°12.2'W	23-10
7	Jacques/Jarvis Lagoon	May 17, 2006	48°55.4'N	125°16.8'W	23-8
8	Pipestem Inlet	May 17, 2006	49°02.3'N	125°12.2'W	23-10
9	Pipestem Inlet	May 17, 2006	49°02.3'N	125°12.2'W	23-10
10	Lemmens Inlet	May 26, 2006	49°13.6'N	125°51.7'W	24-9
11	Lemmens Inlet	May 26, 2006	49°12.8'N	125°50.3'W	24-9
12	Lemmens Inlet	May 26, 2006	49°12.1'N	125°51.6'W	24-9
13	Lemmens Inlet	May 26, 2006	49°11.6'N	125°51.6'W	24-9
14	Lemmens Inlet	May 26, 2006	49°12.0'N	125°53.0'W	24-9
15	Cypress Bay	May 27, 2006	49°16.5'N	125°54.3'W	24-9
16	Cypress Bay	May 27, 2006	49°16.2'N	125°54.6'W	24-9
17	Mosquito Harbour	May 28, 2006	49°13.6'N	125°48.0'W	24-10
18	Tranquil Inlet	May 28, 2006	49°12.6'N	125°40.0'W	24-12
19	Warn Bay	May 28, 2006	49°15.3'N	125°43.9'W	24-10
20	Warn Bay	May 28, 2006	49°15.6'N	125°44.1'W	24-10
21	Cypress Bay	May 29, 2006	49°16.2'N	125°54.8'W	24-7
23	Whitepine Cove	June 10, 2006	49°18.2'N	125°56.9'W	24-5
24	Whitepine Cove	June 10, 2006	49°18.2'N	125°56.9'W	24-5
25	Cypress Bay	June 10, 2006	49°16.3'N	125°54.8'W	24-7
26	Cypress Bay	June 10, 2006	49°16.2'N	125°54.7'W	24-7
27	Whitepine Cove	June 11, 2006	49°19.1'N	125°56.9'W	24-5
28	Bawden Bay	June 11, 2006	49°17.5'N	126°00.4'W	24-4
31	Whiskey Jenny Beach	June 12, 2006	49°23.9'N	126°10.1'W	24-3
32	Whiskey Jenny Beach	June 12, 2006	49°23.9'N	126°10.9'W	24-3
33	Pretty Girl Cove	June 12, 2006	49°28.4'N	126°14.1'W	24-2
34	Pretty Girl Cove	June 12, 2006	49°28.4'N	126°14.1'W	24-2
35	Whitepine Cove	June 12, 2006	49°18.2'N	125°57.0'W	24-5

N.B. – Sets 22, 29 and 30 were deep sets not intending to catch green crab, thus are not included.

Table 4. Continued.

Set	Location	Date	Latitude	Longitude	PFMA
36	Muchalat Inlet	June 14, 2006	49°39.8'N	126°22.4'W	25-3
37	Mooyah Bay	June 14, 2006	49°37.8'N	126°27.0'W	25-3
38	Mooyah Bay	June 14, 2006	49°37.8'N	126°27.2'W	25-3
39	Matchlee Bay	June 14, 2006	49°36.9'N	126°03.1'W	25-1
40	Gold River	June 14, 2006	49°40.8'N	126°06.7'W	25-1
41	Barr Creek	June 15, 2006	49°54.9'N	126°47.2'W	25-9
42	Little Zeballos River	June 15, 2006	49°57.2'N	126°48.7'W	25-10
43	Zeballos	June 15, 2006	49°58.9'N	126°51.1'W	25-10
44	Little Espinosa Middle	June 16, 2006	49°56.9'N	126°54.4'W	25-11
45	Little Espinosa Middle	June 16, 2006	49°56.9'N	126°54.4'W	25-11
46	Little Espinosa Upper	June 16, 2006	49°55.8'N	126°54.4'W	25-11
47	Little Espinosa Upper	June 16, 2006	49°55.8'N	126°54.4'W	25-11
48	Little Espinosa Lower	June 16, 2006	49°55.8'N	126°54.5'W	25-11
49	Espinosa Inlet	June 17, 2006	49°58.1'N	126°56.6'W	25-11
50	Espinosa Inlet	June 17, 2006	49°58.1'N	126°56.6'W	25-11
51	Port Eliza	June 17, 2006	49°54.9'N	126°02.7'W	25-12
52	Port Eliza	June 17, 2006	49°54.9'N	126°02.7'W	25-12
53	Queen Cove Upper	June 17, 2006	49°53.0'N	126°59.0'W	25-12
54	Queen Cove Entrance	June 17, 2006	49°52.5'N	126°58.9'W	25-12
55	Queen Cove Upper	June 18, 2006	49°53.0'N	126°58.9'W	25-12
56	Queen Cove Upper	June 18, 2006	49°53.0'N	126°58.9'W	25-12
57	Queen Cove Upper	June 18, 2006	49°53.0'N	126°58.9'W	25-12
58	Queen Cove Entrance	June 18, 2006	49°52.5'N	126°58.9'W	25-12
59	Queen Cove Entrance	June 18, 2006	49°52.5'N	126°58.9'W	25-12
60	Port Neville	July 12, 2006	50°29.7'N	126°05.3'W	12-25
61	Robber Point	July 12, 2006	50°31.2'N	126°03.8'W	12-25
62	Hanatsa Point	July 12, 2006	50°31.7'N	125°59.5'W	12-25
63	Port Neville	July 12, 2006	50°32.5'N	125°58.5'W	12-25
64	Blenkinsop Bay	July 12, 2006	50°29.2'N	126°07.1'W	12-1
65	Blenkinsop Bay	July 12, 2006	50°29.0'N	125°59.6'W	12-1
66	Jackson Bay	July 13, 2006	50°31.8'N	125°49.3'W	13-37
67	Read Bay	July 13, 2006	50°31.8'N	125°46.8'W	13-37
68	Topaze Harbour	July 13, 2006	50°31.5'N	125°43.4'W	13-37
69	Jackson Bay	July 13, 2006	50°30.9'N	125°45.4'W	13-37
70	Forward Harbour	July 13, 2006	50°29.3'N	125°42.0'W	13-38

Table 4. Continued.

Set	Location	Date	Latitude	Longitude	PFMA
71	Forward Harbour	July 13, 2006	50°29.4'N	125°42.0'W	13-38
72	Shorter Bay	July 14, 2006	50°24.6'N	125°43.9'W	13-40
73	Vere Cove	July 14, 2006	50°23.4'N	125°46.3'W	13-3_
74	Vere Cove	July 14, 2006	50°23.4'N	125°46.3'W	13-32
75	Humpback Bay	July 14, 2006	50°21.7'N	125°41.3'W	13-30
76	Humpback Bay	July 14, 2006	50°21.7'N	125°41.3'W	13-30
77	Lancelot Inlet	July 22, 2006	50°03.6'N	124°42.0'W	15-4
78	Theodosia Inlet	July 22, 2006	50°04.1'N	124°41.5'W	15-4
79	Lancelot Inlet	July 22, 2006	50°04.3'N	124°42.2'W	15-4
80	Okeover Inlet	July 22, 2006	49°58.0'N	124°40.8'W	15-4
81	Okeover Inlet	July 22, 2006	49°58.0'N	124°40.8'W	15-4
82	Prideaux Haven	July 23, 2006	50°08.8'N	124°39.9'W	15-5
83	Prideaux Haven	July 23, 2006	50°08.5'N	124°40.1'W	15-5
84	Eveleigh Island	July 23, 2006	50°08.4'N	124°41.6'W	15-5
85	Pendrell Sound	July 23, 2006	50°16.4'N	124°43.7'W	15-5
86	Pendrell Sound	July 23, 2006	50°17.5'N	124°43.3'W	15-5
87	Von Donop Inlet	July 24, 2006	50°09.6'N	124°57.9'W	13-16
88	Von Donop Inlet	July 24, 2006	50°09.1'N	124°56.9'W	13-16
89	Von Donop Inlet	July 24, 2006	50°08.5'N	124°57.1'W	13-16
90	Von Donop Inlet	July 24, 2006	50°08.4'N	124°56.7'W	13-16
91	Von Donop Inlet	July 24, 2006	50°10.5'N	124°58.3'W	13-16
92	Pipestem Inlet	July 17, 2006	49°02.2'N	125°12.2'W	23-10
93	Pipestem Inlet	July 17, 2006	49°02.3'N	125°12.2'W	23-10
94	Pipestem Inlet	July 18, 2006	49°02.2'N	125°12.2'W	23-10
95	Pipestem Inlet	July 18, 2006	49°02.3'N	125°12.2'W	23-10
96	Pipestem Inlet	July 19, 2006	49°02.2'N	125°12.2'W	23-10
97	Pipestem Inlet	July 19, 2006	49°02.3'N	125°12.2'W	23-10
98	Pipestem Inlet	July 20, 2006	49°02.2'N	125°12.2'W	23-10
99	Pipestem Inlet	July 20, 2006	49°02.3'N	125°12.2'W	23-10
100	Kanish Bay	September 8, 2006	50°14.7'N	125°21.5'W	13-11
101	Kanish Bay	September 8, 2006	50°14.4'N	125°18.8'W	13-11
102	Kanish Bay	September 8, 2006	50°15.8'N	125°17.3'W	13-11
103	Chonat Bay	September 8, 2006	50°17.5'N	125°18.4'W	13-11
104	Chonat Bay	September 8, 2006	50°17.1'N	125°18.4'W	13-11

Table 4. Continued.

Set	Location	Date	Latitude	Longitude	PFMA
105	McKenzie Bight	September 19, 2006	48°33.3'N	123°30.3'W	19-10
106	McKenzie Bight	September 19, 2006	48°33.3'N	123°30.3'W	19-10
107	McKenzie Bight	September 19, 2006	48°33.3'N	123°30.3'W	19-10
108	McKenzie Bight	September 19, 2006	48°33.2'N	123°30.4'W	19-10
109	McKenzie Bight	September 19, 2006	48°33.3'N	123°30.4'W	19-10
110	McKenzie Bight	September 19, 2006	48°33.3'N	123°30.3'W	19-10

Table 5. Catch (number caught) and effort (number of traps) by location and area of European green crab, *Carcinus maenas*, and native crab species from British Columbia trap surveys, May-September 2006.

Location	No. Traps	*C. maenas*	*C. gracilis*	*C. magister*	*C. productus*	*T. cheiragonus*	*P. productus*
Useless Inlet	18	2	8	-	-	-	-
Vernon Bay	6	2	-	-	2	-	-
Robbers Pass	6	-	-	2	17	-	2
Pipestem Inlet	120	274	32	-	-	-	-
Jacques/Jarvis Lagoon	12	-	9	-	2	-	7
Barkley Sound	162	278	49	2	21	0	9
Lemmens Inlet	45	-	58	-	31	-	-
Cypress Bay	64	9	1	2	12	4	39
Mosquito Harbour	24	-	24	-	8	-	-
Tranquille Inlet	6	-	-	1	-	-	-
Warn Bay	12	-	2	1	24	-	14
Whitepine Cove	24	4	4	3	28	-	-
Bawden Bay	6	-	-	-	1	-	-
Whiskey Jenny Beach	12	11	-	-	14	-	5
Pretty Girl Cove	12	17	-	-	-	-	-
Clayoquot Sound	205	41	89	7	118	4	58
Muchalat Inlet	6	-	-	-	-	-	-
Matchlee Bay	6	-	-	-	-	-	-
Mooyah Bay	12	1	-	-	-	-	-
Gold River	6	-	-	-	-	-	-
Barr Creek	6	-	-	2	-	-	-
Little Zeballos River	6	-	-	-	-	-	-
Zeballos	6	1	-	-	-	-	-
Little Espinosa Inlet	35	1	4	-	4	-	-
Espinosa Inlet	12	1	-	1	-	-	-
Port Eliza	12	1	5	-	1	-	-
Queen Cove Upper	24	31	1	1	-	-	-
Queen Cove Entrance	17	20	-	6	-	-	-
Nootka/Esperanza	148	56	10	10	5	0	0

Table 5. continued.

Location	No. Traps	*C. maenas*	*C. gracilis*	*C. magister*	*C. productus*	*T. cheiragonus*	*P. productus*
Port Neville	24	-	6	27	78	-	-
Blenkinsop Bay	12	-	4	10	41	-	-
Topaze Harbour	24	-	27	24	15	-	-
Forward Harbour	12	-	-	-	-	-	-
Shorter Bay	5	-	-	2	10	-	-
Vere Cove	12	-	-	-	36	-	-
Humpback Bay	12	-	-	-	-	-	-
Johnstone Strait	101	0	37	63	180	0	0
Lancelot Inlet	12	-	34	-	48	-	-
Theodosia Inlet	6	-	45	-	8	-	-
Okeover Inlet	12	-	1	-		-	-
Prideaux Haven	12	-	3	-	17	-	-
Eveleigh Island	6	-	-	-	8	-	-
Pendrell Sound	12	-	-	-	13	-	-
Von Donop Inlet	30	-	74	-	4	-	-
Desolation Sound	90	0	157	0	98	0	0
Kanish Bay	18	-	83	1	9	-	-
Chonat Bay	12	-	-	2	114	-	-
Discovery Passage	30	0	83	3	123	0	0
McKenzie Bight	36	0	3	0	328	0	6
Saanich Inlet	36	0	3	0	328	0	6

Table 6. Bycatch (number of individuals) from trap surveys for European green crab, *Carcinus maenas*, in British Columbia, May-September 2006.

Species	BS	CS	N/E	DS	DP	JS	SI	Total
Crustaceans								
C. gracilis	49	89	10	157	83	37	3	428
C. magister	2	7	10	0	3	63	0	85
C. productus	21	118	5	98	123	180	382	927
Crangon sp.	0	1	0	0	0	0	0	1
H. nudus	0	0	0	0	2	0	16	18
H. oregonensis	8	0	0	4	0	0	0	12
O. bifurca	1	0	0	0	0	0	0	1
Paguridae	19	125	179	32	0	3	0	358
P. danae	0	0	0	0	0	0	10	10
P. producta	9	58	0	0	0	0	6	73
T. cheiragonus	0	4	0	0	0	0	0	4
Molluscs								
L. dira	0	48	12	0	0	0	0	60
Echinoderms								
A. miniata	1	9	0	0	0	0	0	10
P. helianthoides	0	8	1	0	1	2	7	19
Fish								
A. fenestralis	0	5	0	0	0	2	1	8
C. asper	18	0	4	0	0	0	0	22
C. aggregata	6	0	1	3	0	0	4	14
E. lateralis	1	0	0	0	0	0	0	1
E. bison	0	0	1	0	0	0	0	1
H. stelleri	0	0	0	2	0	0	2	4
I. tenius	0	0	0	0	0	13	0	13
L. maculatus	0	0	0	0	0	10	0	10
L. armatus	128	120	80	256	84	71	21	760
L. sagitta	0	2	0	0	0	0	0	2
M. polyacanthocephalus	0	1	1	1	0	0	0	3
O. elongatus	0	0	0	0	0	0	1	1
P. vetulus	1	0	0	0	0	0	0	1
P. laeta	6	3	0	0	0	1	0	10
P. ornata	0	1	0	0	0	0	0	1
P. notatus	0	3	0	0	0	0	0	3
R. jordani	0	0	0	0	0	0	3	3
S. caurinus	0	5	7	5	0	0	0	17
S. acanthias	1	0	0	0	1	0	0	2
X. mucosus	0	0	0	0	1	0	0	1

Legend: BS = Barkley Sound, CS = Clayoquot Sound, N/E = Nootka Sound and Esperanza Inlet, DS = Desolation Sound, DP = Discovery Passage, JS = Johnstone Strait, SI = Saanich Inlet. Common and scientific names listed in Appendix Table 1.

Table 7. Collection of live or dead green crab, *Carcinus maenas*, or moults from intertidal NIS surveys in British Columbia, May-July 2006.

Date	Location	Latitude	Longitude	Comments
May 15, 2006	Vernon Bay	49°01'N	125°07'W	1 live
May 17, 2006	Pipestem Inlet	49°02'N	125°12'W	1 moult
May 17, 2006	Hillier Island	49°02'N	125°20'W	1 moult
May 26, 2006	Cypress Bay 1	49°16'N	125°55'W	2 moults
May 26, 2006	Cypress Bay 2	49°17'N	125°54'W	1 moult
May 27, 2006	Warn Bay	49°15'N	125°44'W	1 moult
June 10, 2006	Whitepine Cove	49°18'N	125°57'W	1 live, 3 moults
June 11, 2006	Whiskey Jenny Beach	49°24'N	126°10'W	4 live, 3 moults
June 12, 2006	Pretty Girl Cove	49°28'N	126°14'W	5 moults
June 17, 2006	Queen Cove Upper	49°53'N	126°59'W	2 moults
June 17, 2006	Queen Cove Entrance	49°52'N	126°59'W	1 dead

Table 8. Catch rates (number caught per trap) and effort (number of traps) by location and area of European green crab, *Carcinus maenas*, and native crab species from British Columbia trap surveys, May-September 2006.

Location	No. Traps	*C. maenas*	*C. gracilis*	*C. magister*	*C. productus*	*T. cheiragonus*	*P. productus*
Useless Inlet	18	0.11	0.44	0.00	0.00	0.00	0.00
Vernon Bay	6	0.33	0.00	0.00	0.33	0.00	0.00
Robbers Pass	6	0.00	0.00	0.33	2.83	0.00	0.33
Pipestem Inlet	120	2.28	0.27	0.00	0.00	0.00	0.00
Jacques/Jarvis Lagoon	12	0.00	0.75	0.00	0.17	0.00	0.58
Barkley Sound	162	1.72	0.30	0.01	0.13	0.00	0.06
Barkley Sound (w)	144	1.93					
Lemmens Inlet	45	0.00	1.29	0.00	0.69	0.00	0.00
Cypress Bay	64	0.14	0.02	0.03	0.19	0.06	0.61
Mosquito Harbour	24	0.00	1.00	0.00	0.33	0.00	0.00
Tranquille Inlet	6	0.00	0.00	0.17	0.00	0.00	0.00
Warn Bay	12	0.00	0.17	0.08	2.00	0.00	1.17
Whitepine Cove	24	0.17	0.17	0.13	1.17	0.00	0.00
Bawden Bay	6	0.00	0.00	0.00	0.17	0.00	0.00
Whiskey Jenny Beach	12	0.92	0.00	0.00	1.17	0.00	0.42
Pretty Girl Cove	12	1.42	0.00	0.00	0.00	0.00	0.00
Clayoquot Sound	205	0.20	0.43	0.03	0.58	0.02	0.28
Clayoquot Sound (w)	112	0.37					
Muchalat Inlet	6	0.00	0.00	0.00	0.00	0.00	0.00
Matchlee Bay	6	0.00	0.00	0.00	0.00	0.00	0.00
Mooyah Bay	12	0.08	0.00	0.00	0.00	0.00	0.00
Gold River	6	0.00	0.00	0.00	0.00	0.00	0.00
Barr Creek	6	0.00	0.00	0.33	0.00	0.00	0.00
Little Zeballos River	6	0.00	0.00	0.00	0.00	0.00	0.00
Zeballos	6	0.17	0.00	0.00	0.00	0.00	0.00
Little Espinosa Inlet	35	0.03	0.11	0.00	0.11	0.00	0.00
Espinosa Inlet	12	0.08	0.00	0.08	0.00	0.00	0.00
Port Eliza	12	0.08	0.42	0.00	0.08	0.00	0.00
Queen Cove Upper	24	1.29	0.04	0.04	0.00	0.00	0.00
Queen Cove Entrance	17	1.18	0.00	0.35	0.00	0.00	0.00
Nootka/Esperanza	148	0.38	0.07	0.07	0.03	0.00	0.00
Nootka/Esperanza (w)	118	0.47					

Table 8. continued.

Location	No. Traps	*C. maenas*	*C. gracilis*	*C. magister*	*C. productus*	*T. cheiragonus*	*P. productus*
Port Neville	24	0.00	0.25	1.13	3.25	0.00	0.00
Blenkinsop Bay	12	0.00	0.33	0.83	3.42	0.00	0.00
Topaze Harbour	24	0.00	1.13	1.00	0.63	0.00	0.00
Forward Harbour	12	0.00	0.00	0.00	0.00	0.00	0.00
Shorter Bay	5	0.00	0.00	0.40	2.00	0.00	0.00
Vere Cove	12	0.00	0.00	0.00	3.00	0.00	0.00
Humpback Bay	12	0.00	0.00	0.00	0.00	0.00	0.00
Johnstone Strait	101	0.00	0.37	0.62	1.78	0.00	0.00
Lancelot Inlet	12	0.00	2.83	0.00	4.00	0.00	0.00
Theodosia Inlet	6	0.00	7.50	0.00	1.33	0.00	0.00
Okeover Inlet	12	0.00	0.08	0.00	0.00	0.00	0.00
Prideaux Haven	12	0.00	0.25	0.00	1.42	0.00	0.00
Eveleigh Island	6	0.00	0.00	0.00	1.33	0.00	0.00
Pendrell Sound	12	0.00	0.00	0.00	1.08	0.00	0.00
Von Donop Inlet	30	0.00	2.47	0.00	0.13	0.00	0.00
Desolation Sound	90	0.00	1.74	0.00	1.09	0.00	0.00
Kanish Bay	18	0.00	4.61	0.06	0.50	0.00	0.00
Chonat Bay	12	0.00	0.00	0.17	9.50	0.00	0.00
Discovery Passage	30	0.00	2.77	0.10	4.10	0.00	0.00
McKenzie Bight	36	0.00	0.08	0.00	9.11	0.00	0.17
Saanich Inlet	36	0.00	0.08	0.00	9.11	0.00	0.17

Weighted (w) catch rates include only sites where green crab were collected.

Table 9. Counts by sex and area and sex ratio (% male) of European green crab, *Carcinus maenas*, from British Columbia surveys, May-September 2006.

Sound	No. Male	No. Female	Total	% male
Barkley	168	106	274	61.3%
Clayoquot	35	9	44	79.5%
Nootka/Esperanza	46	11	57	80.7%
Total	249	126	375	66.4%

Table 10. Age structure of male European green crab, *Carcinus maenas*, from British Columbia surveys, May-September 2006.

		Number in Year Class				Percent in Year Class		
Sex	Area	2006	2005	Older	Total	2006	2005	Older
Male	Barkley	1	151	16	168	0.6	89.9	9.5
	Clayoquot	5	14	16	35	14.3	40.0	45.7
	Nootka/Esperanza	0	43	3	46	0.0	93.5	6.5
	Total	6	208	35	249	2.4	83.5	14.1
Female	Barkley	2	94	10	106	1.9	88.7	9.4
	Clayoquot	3	4	2	9	33.3	44.4	22.2
	Nootka/Esperanza	0	9	2	11	0.0	81.8	18.2
	Total	5	107	14	126	4.0	84.9	11.1
Combined	Barkley	3	245	26	274	1.1	89.4	9.5
	Clayoquot	8	18	18	44	18.2	40.9	40.9
	Nootka/Esperanza	0	52	5	57	0.0	91.2	8.8
	Total	11	315	49	375	2.9	84.0	13.1

Table 11. Shell condition by sex for European green crab, *Carcinus maenas*, from British Columbia surveys, May-September 2006.

Shell Condition	Sex				Percent		
	Male	Female	Ovigerous	Total	Male	Female	Total
Plastic	0	0	0	0	0.0	0.0	0.0
New Soft	2	0	0	2	0.8	0.0	0.5
New Springy	8	2	0	10	3.2	1.6	2.7
New Hard	199	106	1	298	77.0	85.6	79.9
New-Old	12	4	0	16	4.8	3.2	4.3
Old	32	11	0	43	12.9	8.8	11.5
Very Old	3	1	0	4	1.2	0.8	1.1
Moulting	0	0	0	0	0.0	0.0	0.0
Moult	0	1	0	3	0.0	0.8	0.8
Total	248	124	1	373	100.0	100.0	100.0

N.B. - Shell conditions are described in Table 2.

Table 12. Shell colour and condition for European green crab, *Carcinus maenas*, from British Columbia surveys, May-September 2006.

Shell Condition	Colour					Percentage	
	Yellow	Green	Orange	Red	Total	Yellow-Green	Orange-Red
Plastic					0		
New Soft	2				2	100.0	0.0
New Springy	9	1			10	100.0	0.0
New Hard	65	227			292	100.0	0.0
New-Old	7	8	1		16	93.8	6.3
Old	15	5	20	1	41	48.8	51.2
Very Old	1	1	1	1	4	50.0	50.0
Moulting					0		
Total	99	242	22	2	365	93.4	6.6

Table 13. Incidence of injuries and missing limbs by location for European green crab, *Carcinus maenas*, from British Columbia surveys, May-September 2006.

Location	No. of Crabs				% Damaged
	Injured	Missing Claws	Missing Legs	Examined	
Cypress Bay	0	0	0	9	0.0
Little Espinosa	0	0	0	2	0.0
Mooyah Bay	0	0	0	1	0.0
Queen Cove	1	8	1	52	19.2
Pipestem Inlet	10	13	18	274	15.0
Pretty Girl Cove	0	3	1	17	23.5
Useless Inlet	0	0	0	2	0.0
Vernon Bay	0	0	0	2	0.0
Whitepine Cove	0	0	0	4	0.0
Whiskey Jenny Beach	1	3	1	14	35.7
Zeballos	0	0	0	1	0.0
Total	12	27	21	378	15.9

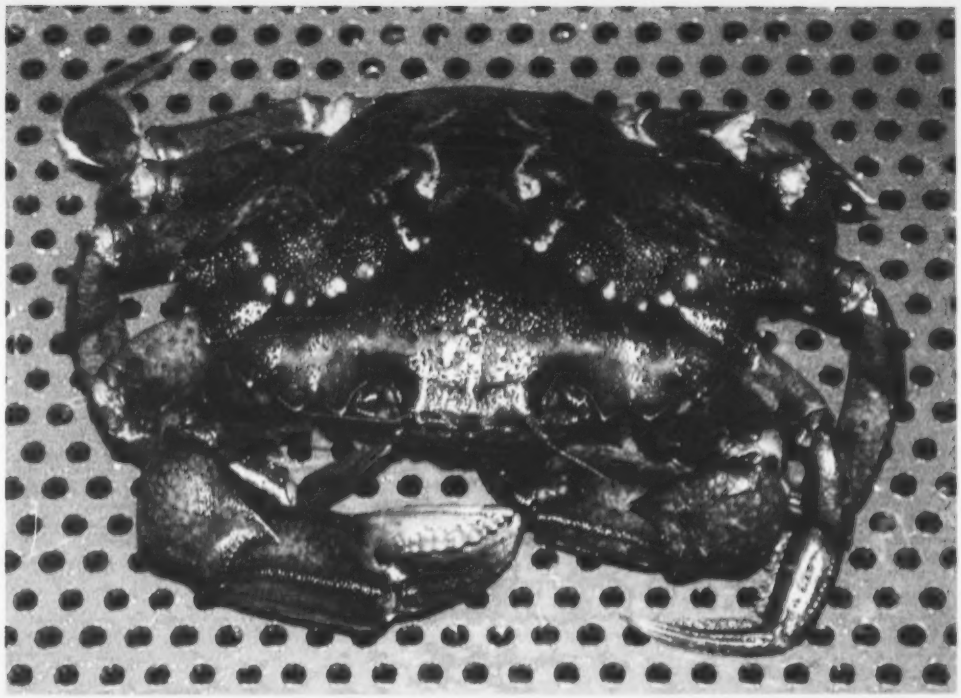


Figure 1. The European green crab, *Carcinus maenas* (Linnaeus, 1758).

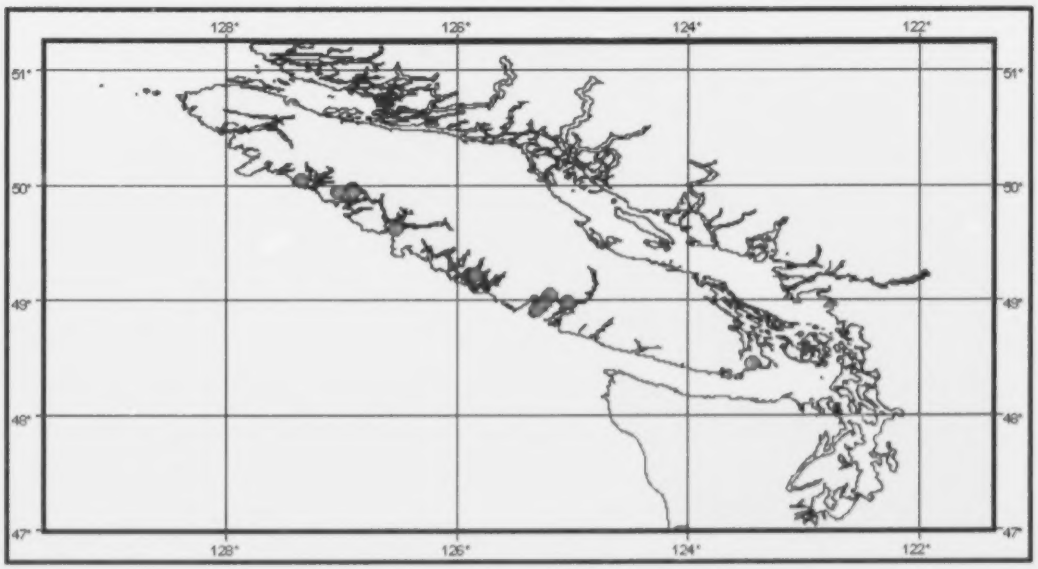


Figure 2. Historic collection locations of European green crab, *Carcinus maenas*, in British Columbia, 1999-2006.

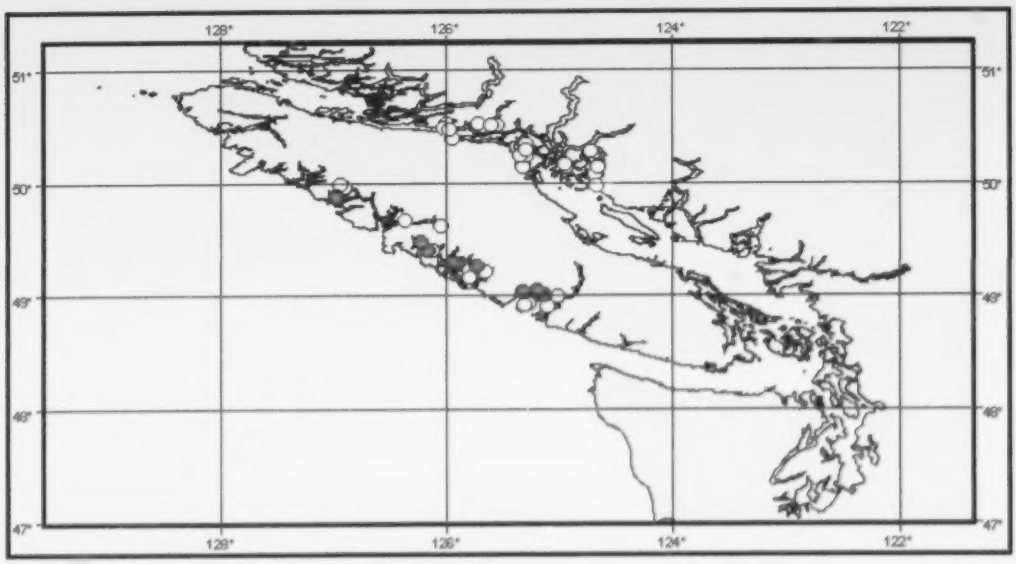


Figure 3. Collection locations of European green crab, *Carcinus maenas*, from beach surveys conducted in British Columbia, May-September 2006.

Legend: Open circles are locations surveyed; filled circles are locations with green crab or moults collected.

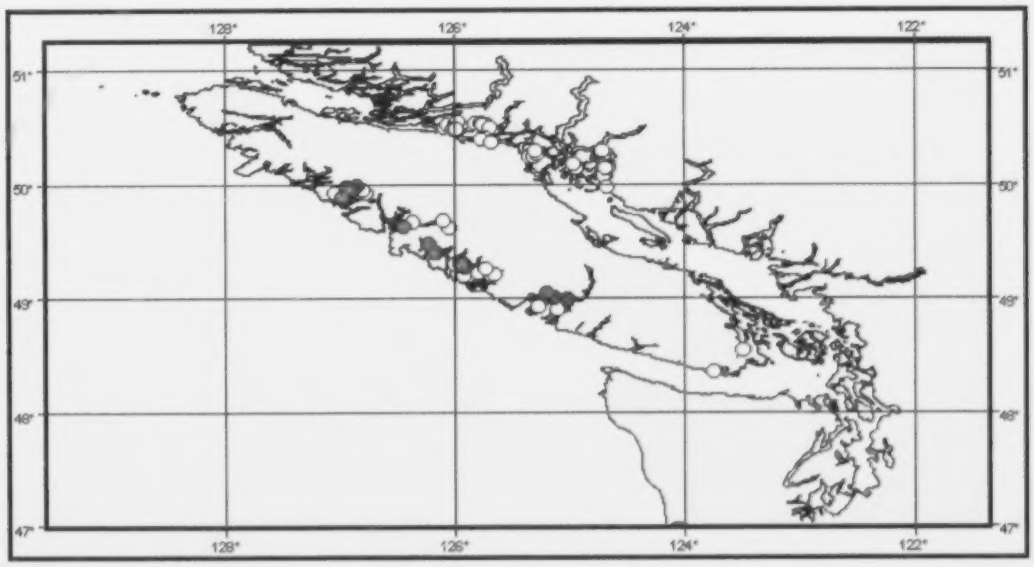


Figure 4. Collection locations of European green crab, *Carcinus maenas*, from trap surveys in British Columbia, May-September 2006.

Legend: Open circles are locations surveyed, filled circles are locations with green crab collected.

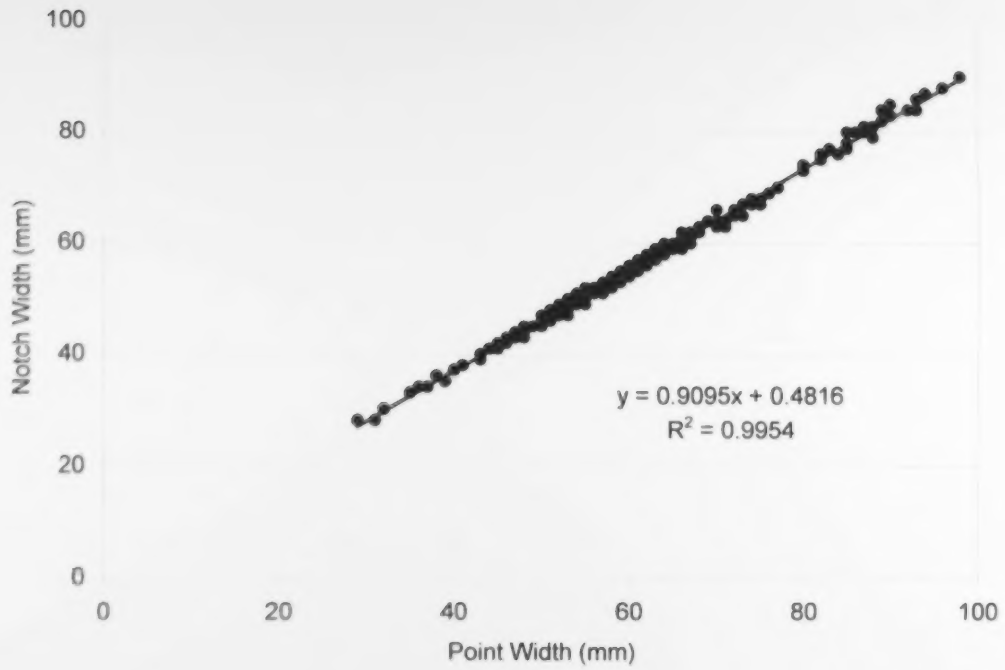


Figure 5. Regression plot of European green crab, *Carcinus maenas*, carapace width (mm) measured notch to notch (Canadian standard measurement) to carapace width measured point to point (US standard measurement).

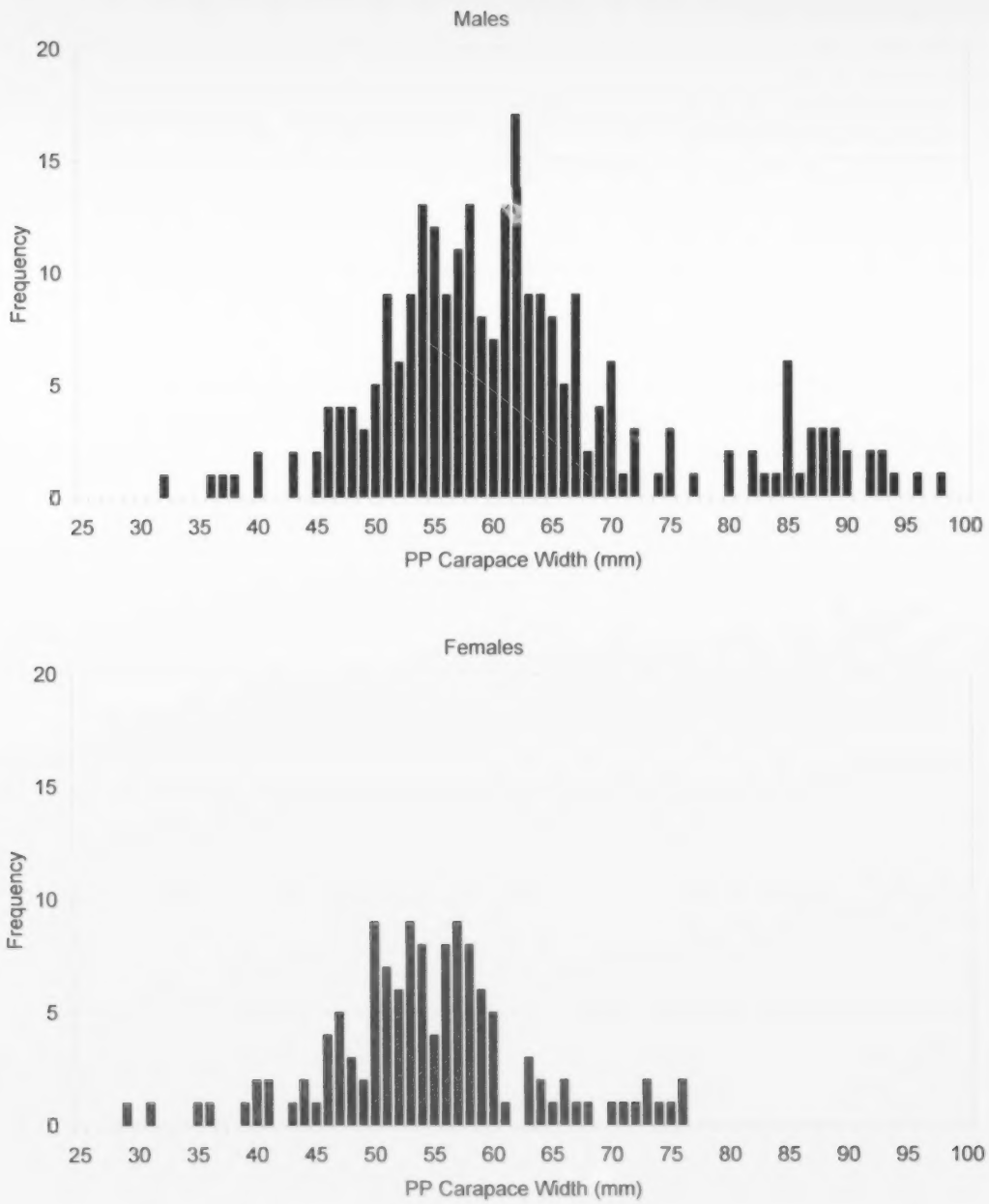
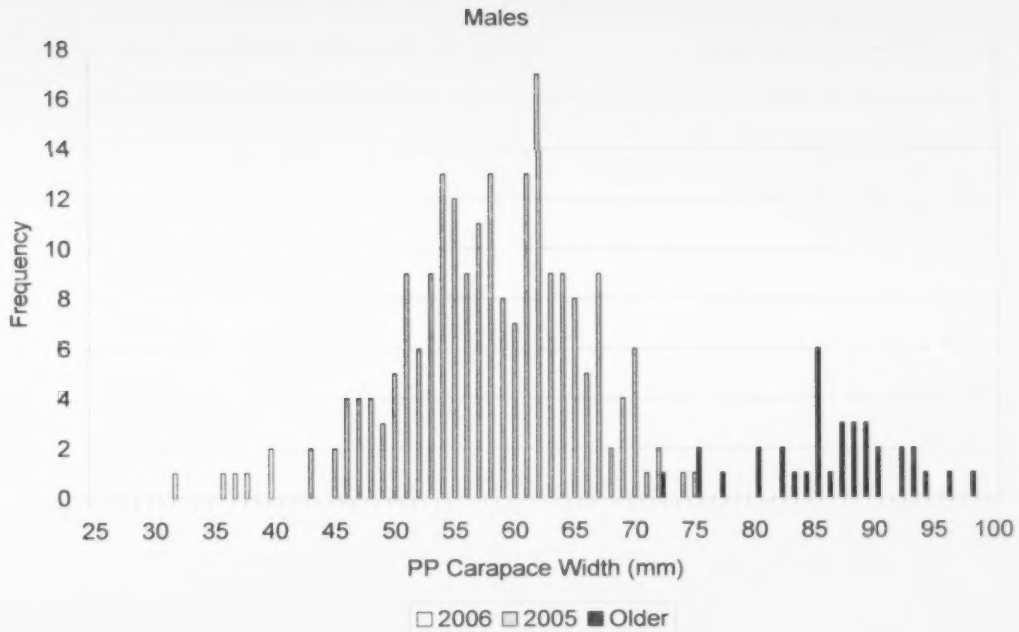


Figure 6. Carapace width frequencies (mm, point to point) of male (upper panel) and female (lower panel) European green crab, *Carcinus maenas*, collected in British Columbia, May-July 2006.



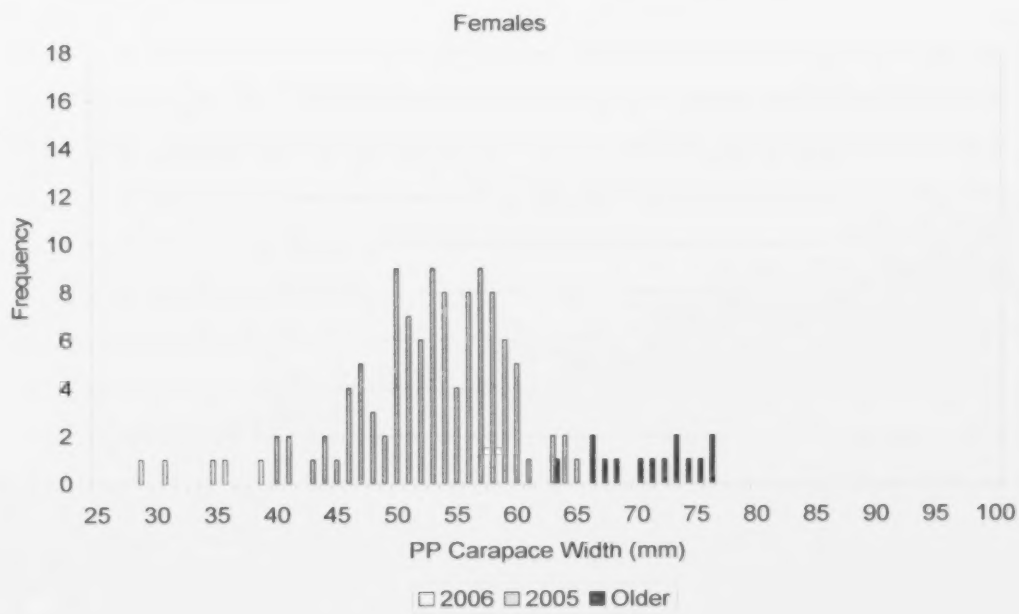


Figure 7. Carapace width (mm, point to point) by year class for European green crab, *Carcinus maenas*, collected in British Columbia surveys, May-July 2006.

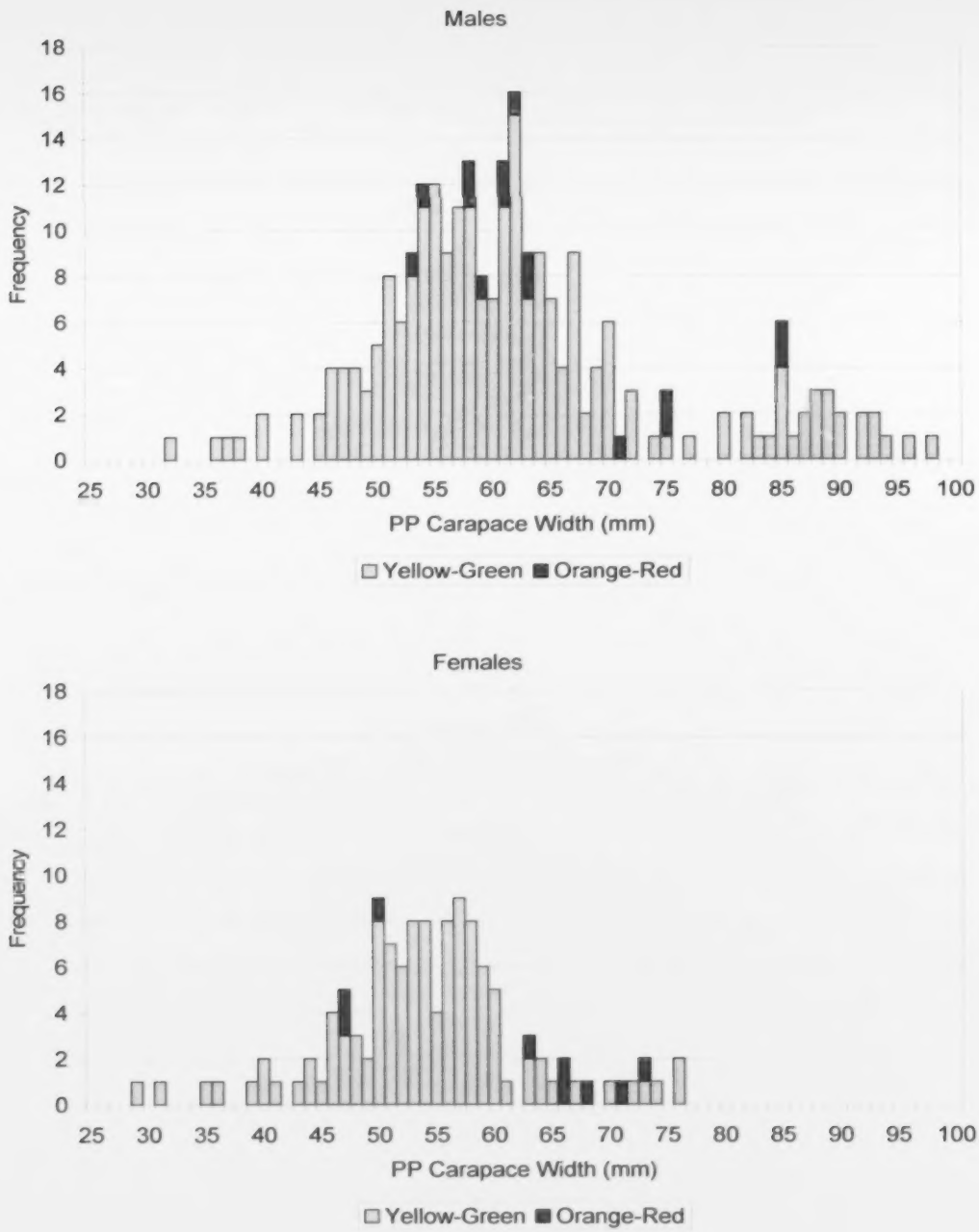


Figure 8. Carapace width frequency (mm, point to point) by shell color of male European green crab, *Carcinus maenas*, collected in British Columbia trap surveys, May-July 2006.

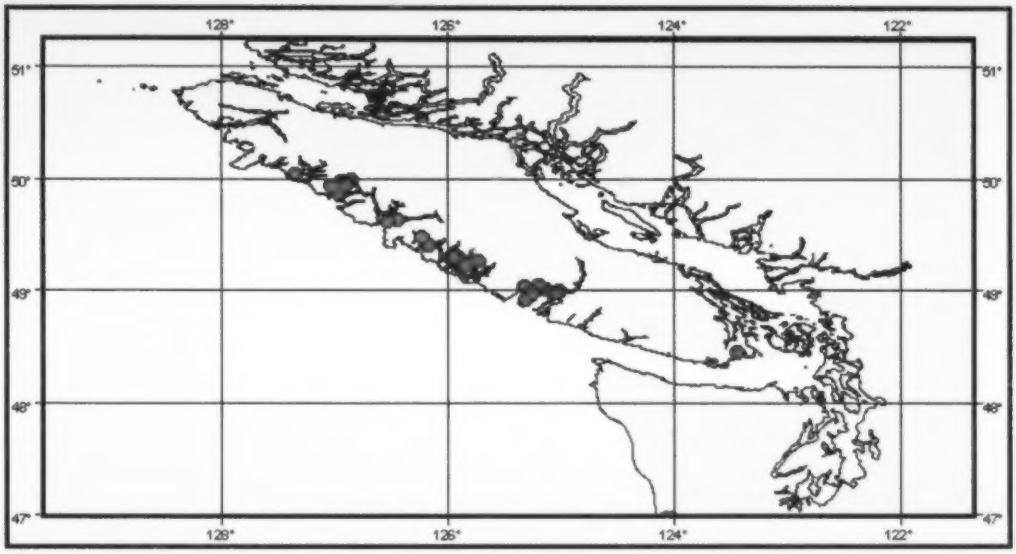


Figure 9. Collection locations of European green crab, *Carcinus maenas*, in British Columbia from all sources, 1999-2006.

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Appendix Table 1. Common and scientific names of species encountered during trap surveys for European green crab, *Carcinus maenas*, in British Columbia, May-September 2006.

Common name	Scientific Name	Common Name	Scientific Name
		Crustaceans	
Graceful crab	*Cancer gracilis*	Yellow shore crab	*Hemigrapsus oregonensis*
Dungeness crab	*Cancer magister*	Splitnose crab	*Oregonia bifurca*
Red rock crab	*Cancer productus*	Hermit crab	Paguridae
European green crab	*Carcinus maenas*	Coonstripe shrimp	*Pandalus danae*
Bay shrimp	*Crangon* sp.	Northern kelp crab	*Pugettia producta*
Purple shore crab	*Hemigrapsus nudus*	Helmet crab	*Telmessus cheiragonus*
		Molluscs	
Dire whelk	*Lirabuccinium dirum*		
		Echinoderms	
Bat star	*Asterina miniata*	Sunflower star	*Pycnopodia helianthoides*
		Fish	
Padded sculpin	*Artedius fenestralis*	Great sculpin	*Myoxocephalus polyacanthocephalus*
Prickly sculpin	*Cottus asper*		
Shiner perch	*Cymatogaster aggregata*	Lingcod	*Ophiodon elongatus*
Striped seaperch	*Embiotoca lateralis*	English sole	*Parophrys vetulus*
Buffalo sculpin	*Enophrys bison*	Crescent gunnel	*Pholis laeta*
Whitespotted greenling	*Hexagrammos stelleri*	Saddleback gunnel	*Pholis ornata*
Spotfin sculpin	*Icelinus tenuis*	Plainfin midshipman	*Porichthys notatus*
Daubed shanny	*Leptoclinus maculatus*	Northern ronquil	*Ronquilus jordani*
Pacific staghorn sculpin	*Leptocottus armatus*	Copper rockfish	*Sebastes caurinus*
Pacific snake prickleback	*Lumpenus sagitta*	Spiny dogfish	*Squalus acanthias*
		Rock prickleback	*Xiphister mucosa*